

# Regional Equilibrium and Migration Patterns in the Americas 1960-2005: Spatial Data Panel Analysis\*

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## ABSTRACT

This paper analyzes the migration dynamics in the Americas from 1960 to 2005 using an equilibrium approach. The migration flow is evaluated using spatial econometrics techniques and controlling for the labor mobility effect and regional wages. Additionally, the estimated model looks for variations in migration by taking into account the distinctive population features in each country, namely the working age population, unemployment rate and relative wages. The estimated model shows that the spatial equilibrium related to net migration is negatively affected by wages and positively influenced by labor supply in the region.

**Key Words:** migratory flows, spatial equilibrium, spatial data panel

## INTRODUCTION

During the last four decades, there has been an important migratory movement at the Americas region, with a greater force in the late of

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1980s because of the desire to improve the socioeconomic situations of migrants and their families in their places of origin. Although, it is argued that free mobility of factors is essential for the equalization of wages and prices in the long-term, a detailed analysis of mobility can provide indications of how people's motivations affect the relocation of labor in a foreign country. Such analysis could also provide administrative and political constraints that influence the geographical definition and intensity of migration flows.

The international movement of people affects both the economic growth and the economic development (welfare) of countries from which these people emigrate and countries to which they immigrate. In this vein, considering why people decide to migrate can be an important point of departure for the design of public and international policies around the world in order to improve immigrant conditions without worse those of the local population.

The international literature presents some of the main reasons why people decide to migrate, including economic conditions such as differences in income, low unemployment, or climate issues such as temperature of the country of destination. Another reason lies in the altruistic view that people have of their families. In many cases, people migrate to send money to their relatives in their countries of origin, and is for this reason that the main migrants who send remittances to their families come from developing countries. These remittances have an effect, although not a direct impact, on economic growth and economic development, as this money comes to be invested primarily in education and industry, which in turn influences learning, domestic saving, and health (World Bank 2008). In short, if trade can improve the welfare of the whole world, migration can also improve welfare. However, the literature also exposes some negative effects of migration, especially illegal migration and the so-called brain drain when qualified people in a country decide to migrate to higher income countries.

Numerous papers have investigated the economic determinants of migration, theoretically and empirically, from the hypotheses proposed in Sjaastad (1962), Todaro (1969), Harris and Todaro (1970), Borjas (1987), Greenwood (1975; 1985; 1989; 2001) and Greenwood and Hunt (1993), among others. Greenwood (1975) reviewed the major contributions to migration made by economists to that date, grouping these two types of models into gross and net migration. The first type of approach, the most common, was developed under the framework of the expected utility maximization of each individual. However, in the mid-1980s the approach

began to include economic factors linked to family and housing, which are the most important at the time, to estimate the determinants of migration<sup>1</sup>. In the second case, the interest in gross migration lies in knowing the outcome of the migration process in each local labor market.

By contrast, Sjaastad (1962) introduced the concept of human capital investment, based on the previous work developed by Becker (1964). Sjaastad considered individual migration decisions to be a resources allocation problem. When individuals migrate, this increases the productivity of individual human resources, subject to some costs and benefits, and thus such rises are ultimately the determinants of the decision to migrate.

The results of econometric studies of immigration have not always produced results in accordance with economic theory. For example, the level of aggregate income is negatively related to migration (Greenwood and Hunt 1993). Additionally, most of the empirical studies of the determinants of internal migration relegate the issue of international migration to a purely descriptive analysis. This paper thus examines revenue adjustments in regional labor markets and the specificities of each node of job attractors.

Since the analysis of spatially interrelated phenomena such as migration began to take into account the possible existence of spatial dependence between different areas or units of study and control for this spatial dependence, better conclusions about the dynamics of migration to the Americas have been drawn.

The approach used here in order to explain net migration follows authors as Jeanty et al. (2010) and Waltert and Schiäpfer (2010). We study the dynamics of migration in the Americas from 1980 to 2005 using an equilibrium approach determined by the inclusion of a spatial factor, which controls for the flow of migration between countries. Equilibrium is reached when the space factor determines the equilibrium migration flows given its determinants. This space approach proposed by Graves (1976), Graves and Linneman (1979) and Lucas (2004) introduced compensation locational factors, qualitative differentials in the labor market and productivity but does not include the geographical influence of neighboring locations and their conditions in the decision to migrate. Our approach contributes to the existing empirical literature because of the inclusion of a spatial lag to model the spatial factors determining migration flows.

This paper is organized as follows. The second section presents some stylized facts obtained in previous work on migration. The third section

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1 See for example Mincer (1978) and Borjas (1989).

presents the data and econometric model specification. The fourth section presents the empirical results of the estimates. We conclude in the final section.

## STYLIZED FACTS AND LITERATURE REVIEW

According to World Bank, in 2010 3.2% of the world's population was immigrants, about 215.8 million people, of which 48.4% were women. Over 43% of the population who has emigrated did it from developing countries to other developing countries. Migration in the Americas has been studied from the World Bank. In 2011, this institution published data on global migration and remittances. The U.S. has the highest proportion of immigrants, with 43 million, followed by Russia with 12 million. By 2010, the largest migration corridor in the world was Mexico-U.S., with 11.6 million migrants. Additionally, migration between developing countries is higher than migration between developing countries and developed countries, or those that belong to the OECD.

Moreover, Mexico is ranked within the top three countries receiving remittances from the rest of the world, with 22.6 billion dollars; in 24th place is Brazil with 4.3 billion dollars, while Colombia is in 27th place with 3.9 billion dollars. These remittances are mostly sent from the U.S., Spain, Germany and Italy. Table 1 presents flows of remittances worldwide (both inside and outside). It shows that the percentage of remittances flows to developing countries is increasing, from 54.5% in 1995 to 74% in 2010. Moreover, the percentage of remittance flows from developing countries to developed countries has increased considerably.

Table 1. Remittances worldwide

	1995	2000	2005	2006	2007	2008	2009	2010
<b>Inward remittance flows</b>	101.3	131.5	274.9	317.9	385	443.2	416	440.1
<i>All developing countries</i>	55.2	81.3	192.1	226.7	278.5	324.8	307.1	325.5
<b>Outward remittance flows</b>	97.5	108.5	185.3	213.7	255.2	295.7	282.5	--
<i>All developing countries</i>	10.4	9.5	33	41	52.7	67.3	58.7	--

Note: The units are in billion dollars.

Source: World Bank.

Several studies of migration in Latin America have examined the determinants and causes of both immigration and emigration in the main countries of origin and destination. Pellegrino (1993; 2000; 2001) has contributed to issues such as brain drain, migration between developing

and developed countries, relative wage influences and gender, among others.

A recent study by the OECD, CEPAL and OAS (2011) showed that migration has been increasing since 1950 from the countries of Latin America and the Caribbean to developed countries such as the U.S. and Canada. Emigration has also been a topic of great importance from the 1960s for Latin America and the Caribbean, although in recent years its flow has been reduced due to the financial crises that have shaken the world. For small and island countries, expatriation rates tend to be high because of the lack of educational and employment opportunities. However, intraregional migration between neighboring countries remains crucial, which tends to be gradual (see the case of Argentina, Costa Rica, Venezuela and Chile). This study focused on nine countries: Argentina, Belize, Canada, Chile, Colombia, Ecuador, El Salvador, Mexico and Uruguay, while Argentina and Chile were the two main destinations of regional migrants.

OECD, CEPAL and OAS (2011) used several data sources in order to analyze the magnitude, trends and characteristics of international migration. It aimed to contribute to the development of public policies that improve facilities regarding dialogue, capacity building, access to information and others to foster migration to the Americas: "This report builds on the methodological model of Continuous Reporting System on Migration (SOPEMI) of the [OECD], in line with the needs of the region according to a participatory process of countries of the Americas through its national correspondents and the participation of national and international organizations working around the issue of migration".

Sasser (2010) examined migration trends in the U.S. to determine what kinds of policies should be developed to create an impact on the local workforce. This paper used data from the Internal Revenue Service for 48 U.S. states between 1977 and 2006, taking into account three factors (economic labor (market conditions), per capita income and housing affordability) to determine a state's internal state given these migratory flows. The author concluded that economic factors are determinants of migration, although these factors vary according to their importance and over time. The labor market and income per capita have had the greatest impact on migration between states, with housing availability secondary. Since 1980, the importance of housing affordability has increased, while the influence of the other two factors has diminished. The costs of housing and employment growth both contributed almost in the same proportion between 1997 and 2006. Recent changes in the economic environment affect states differently. The author makes some warnings about the model:

it tends to overestimate and underestimate booms and recessions, it does not take into account other factors that may affect the migration of particular groups (e.g. state taxes) and migrants are self-selected by region and the return of skills.

As argued by Sasser (2010), the migration of young people in some states is more representative, as evidenced by the fact that public policies should be evaluated in terms of future competition among skilled workers who migrate between states. For the policy to be effective, it is necessary to know the factors affecting migration and the changes in these factors over time.

In Latin America, no econometric studies have examined the determinants of net migration in the Americas by incorporating a spatial component. However, BID (2010) estimated an econometric model to assess the economic impact of international migration in Colombia for 24 departments. This report concluded that for this country the stock of migrants abroad is concentrated in three countries: the U.S., Venezuela and Spain. Given the events of September 11, 2001 in the U.S., Colombians began to migrate to Spain at a rate of more than 15 times the stock of Colombian migrants. Although, there is a rapid and progressive decentralization in the Colombian community from the Mediterranean coast to the Atlantic coast. The main destination remains the U.S., which has a high geographic concentration of migrants Colombians, while Venezuela has some migration over time. However, mainly due to differences in household income in both countries, Colombian migrants are behind of access to communication services, education and housing. In the U.S., Colombian migrant labor has almost the same benefits as native workers and shows better grades than their local counterparts, which provides Colombian migrants with easy links to labor markets.

However, international migration, according to the study, has only a moderate expansionary impact. For example, Colombia's GDP increased by 0.83% in 2007–2020 because of the increased purchasing power of households due to increased remittances, the cheaper price of imported consumer goods owing to the appreciation of the exchange rate due to the inflow of remittances and foreign capital, and the increased wages associated with the departure of emigrants. International migration creates a ripple effect (via internal consumption) and a contraction (via the trade balance deterioration) in economic activity, the first one being dominant. This economic situation benefits the sectors producing goods and services of great importance in the consumption basket of households, while international migration reduces gender wage gaps in Colombia.

## DATA AND MODEL SPECIFICATION

This section presents the specification and estimation of a traditional model with a relatively new empirical application, as provided by recent advances in spatial econometrics to include spatial relationships that affect migration.

### Data

To evaluate the effects of the regional migration balance, we take into account data from 19 countries across the continent, excluding the Caribbean islands, the Guianas and Belize. For countries of study, we construct a panel dataset from 1960 to 2005, using data for five-year net migration variables, excluding real wages and the percentage of the population aged between 15 and 65<sup>2</sup>.

Owing to the temporal characteristics of the information and availability of data from different countries, we cannot display additional variables offsetting the effects of regional migration flows, as proposed by Jeanty et al. (2010). Further, the observed data of net migration is taken with some doubt in the case of Bolivia because of the imprecisions with the official database used.

Here, net migration is taken as the gross number of people emerging from entering the country per 100,000 inhabitants. The wage differential was constructed using the real wage index adjusted for each country of reference, in this case the U.S.

Finally, we take the proportion of the population between 15 and 65 years, namely the working age population in the country of origin, as a proportion of the total population. This variable can incorporate growth in the working age population as an incentive to migrate due to increased competition for skilled and unskilled migrants.

### Econometric Model

For the assessment of spatial factors for migration in the Americas, we turn to the basic specifications of spatial econometrics. These kinds of models can control for the effect of spatial dependency in previous analyses of migration. Anselin (1988) and LeSage and Pace (2009) stated

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2 Annex A2 describes the sources of information which are taken or from which they are constructed of the study variables.

that if a model is estimated econometrically and presents spatial dependence that is not controlled for, the estimators are biased and inefficient. Therefore, a full analysis of these relationships must be carried out to determine whether the spatial relationships are strong enough to be taken into account. In our approach to spatial econometrics, we estimate a panel data model by controlling for factors to analyze the spatial derivatives that affect the locational equilibrium relationship between our variables of interest (LeSage and Pace 2009; Elhorst 2010).

Although the approaches to data-generating processes in spatial econometrics show significant variation, we turn in this case to an SAR-type specification (Autoregressive Spatial Regression), including in the functional form the spatially lagged dependent variable<sup>3</sup>:

$$Y = \delta WY + X\beta + \varepsilon \quad (1)$$

refers to the spatial weight matrix, which specifies the neighborhood of the spatial units being analyzed and introduces interdependence between neighborhoods for each of these units. This matrix has the dimension of the number of location that are analyzed, is non-negative and has zero elements on its main diagonal. Generally, this matrix is normalized in the way that sums of the rows of the matrix equal unity (LeSage and Pace 2009).

The coefficient associated with the spatial lag of the dependent variable measures the degree of spatial interdependence of each of these units compared with what is observed for its neighbors. has all the control variables to the dependent and is an error with normal properties.

In this case, we perform a spatial pooled regression approach, in which the variable space for the derived dependent  $i$  at time  $t$  can be explained by its special lag for the same period as well as by information on the control variables for that variable and at that specific time<sup>4</sup>.

For each observation in a specific period, such an equation takes the form:

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3 No other specifications are included as spatially lagging errors, since the SAR model is consistent with the idea that the migration of a country may depend on the migration observed by its neighbors, as in the case of Central America.

4 This is the basic specification of a spatial panel data model, which assumes that no fixed effects of each spatial unit affect the unbiasedness of coefficients. For an elaboration of the specifications, see Elhorst (2010a).



$$y_{it} = \delta \sum_{j=1}^N w_{ij} y_{jt} + \alpha + x_{it} \beta + \varepsilon_{it} \quad (2)$$

To ensure the stationarity of the process, where  $\delta$  and  $\alpha$  are the smaller and larger characteristic roots of the  $W$  matrix, respectively<sup>5</sup>.

An extension of this model is known as the spatial Durbin model (Anselin 1988), which includes the lag of the dependent and spatial lags of the independent variables, deriving the following equation<sup>6</sup>:

$$y_{it} = \delta \sum_{j=1}^N w_{ij} y_{jt} + \alpha + x_{it} \beta + \sum_{i=1}^N w_{ij} x_{jt} \Theta + \varepsilon_{it} \quad (3)$$

where the parameter vector  $\Theta$  collects information on the effect of spatial dependence with the independent variables on the dependent variable through a spatial average of each of the neighbors of the spatial unit of analysis. For this case, we use the spatial autoregressive model applied to a panel of observations of different American countries for which data are available, as in equation 2.

## ESTIMATIONS AND EMPIRICAL RESULTS

In this paper, we estimate two econometric specifications that take into account the working conditions of each of the countries of the continent. An exploratory spatial analysis of the data suggests a strengthening of spatial dependence with the central axis of reception of immigrants in U.S. in North America and Chile in South America as well as El Salvador and Mexico, along with Colombia, Ecuador and Bolivia as the main repulsors of population.

It explains the behavior of net migration defined as the difference between people who leave a country less those that arrive, as a function of the real wage differential between the location attracting the migrant

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5 Compared with that is assumed in time series data,  $\delta$  is not necessarily greater than -1 (Elhorst 2010b).

6 Lesage and Pace (2009) argued that the specification of the spatial Durbin model is justified as it can present a correlation between the errors of the conventional equation, which can be spatially correlated with the control variables. Assuming a structure for those errors with one spatial component, we ascertain the data-generating process of equation (2).

population, the unemployment rate by country and the proportion of the population in the country that can become migrant workers.

The equations are estimated using the maximum likelihood method<sup>7</sup>, for the case of the SAR and spatial Durbin models:

$$\text{NetMig}_{it} = \delta \sum_{j=1}^N w_{ij} \text{NetMig}_{jt} + \alpha + \beta_1 \text{RelWages}_{it} + \beta_2 \text{Unemp}_{it} + \beta_3 \text{Pop}_{it} + \varepsilon_{it} \quad (4)$$

and

$$\begin{aligned} \text{NetMig}_{it} = & \delta \sum_{i=1}^N w_{ij} \text{NetMig}_{jt} + \alpha + \beta_1 \text{RealWages}_{it} + \beta_2 \text{Unemp}_{it} + \beta_3 \text{Pop}_{it} \\ & + \sum_{i=1}^N \theta_1 w_{ij} \text{RealWages}_{jt} + \sum_{i=1}^N \theta_2 w_{ij} \text{Unemp}_{jt} + \sum_{i=1}^N \theta_3 w_{ij} \text{Pop}_{jt} + \varepsilon_{it} \end{aligned} \quad (5)$$

To determine the possible effect of spatial dependence in the performed analysis, scatterplots based on the Moran index for each sample year are created. This suggests a possible positive spatial dependence of net migration in the Americas (see the figures in Appendix A).

This implies that those countries with negative migration rates (net attractors) have neighbors who also have these rates and that countries with positive migration rates (net repulsors) have neighbors who also demonstrate that behavior. The LISA map found in the appendix shows graphically this statement and its evolution over time. As it can be seen, the strengthening of the countries that have been cited as the main recipient/ejector population and how neighboring countries are part of their respective population dynamics in space.

To assess the country of reference to determine the real wage differentials, we carried out a local Moran test, which is clear in terms of attracting labor (see Appendix A). The U.S. always shows a significant spatial coefficient, which not only is confirmed as the main attraction of migrants in the continent but also is characterized by a strong dynamic flow in terms of migrant employment. The main empirical findings are presented in Table 2.

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<sup>7</sup> The pooled estimate of spatial regression is performed using the software Matlab, using spatial econometrics toolbox made by LeSage, and a set of functions to estimate spatial panel data constructed Elhorst, all routines are available on the website of the authors.

Table 2. Pooled regression for net migration in the Americas

	Dependent Variable : Net Migration			
	Pooled with spatially lagged dependent variable		Pooled with spatially lagged dependent and independent variables	
	Coefficient	P - Value	Coefficient	P - Value
Intercept	13821.337	0.000	15633.226	0.000
Relative Wage	-397.256	0.068	-477.886	0.021
Unemployment	40.261	0.207	42.779	0.164
Population	-220.528	0.000	-204.911	0.000
W*Net migration	0.252	0.005	0.261	0.006
W*Relative Wage	-	-	-355.308	0.403
W*Unemployment	-	-	-183.258	0.000
W*Population	-	-	-13.562	0.819
Log - likelihood	-988.838		-981.023	
R - Squared	0.4603		0.5303	
	P - Value		P - Value	
LM test no spatial lag	1.1367	0.286	1.4193	0.234
Robust LM test no spatial lag	9.830	0.002	25.594	0.000
LM test no spatial error	0.0262	0.872	0.0215	0.883
Robust LM test no spatial error	8.719	0.003	24.197	0.000

After testing for robustness and error properties –regular and spatial ones–<sup>8</sup>, it is determined that the best functional form to estimate net migration is the pooled regression. The first panel of the table shows the results of the estimates for an autoregressive panel, while the second panel takes the functional form of the spatial Durbin panel type, summarized in equations 4 and 5, respectively.

The signs of the coefficients are as expected for the variables used in the estimation. In this case, it is estimated that increases in the country wages lead to a lower reference population expulsion and exert a greater attraction for people. Meanwhile, increases in unemployment lead to countries becoming ejectors. Finally, population growth and migration flows lead to the exit of people, a result that is consistent with labor market movements in a regional context, as discussed by Borjas (1987).

In both cases, the spatial dependence of migration flows is significant

8 Reader has to do a careful reading of results due to sample size and the problems of it in the main tests related to the model identification (Debarys and Erthur 2010). For example, despite of results of robust test to identify spatial dependence, other models evaluated do not show significant coefficients in the respective structure.

but weak in terms of magnitude. This result is consistent with the idea that migration is a regional phenomenon that is determined not only by local conditions to each country but also by what happens in neighboring countries.

Panel B (right) in the table highlights an additional idea that supports the result obtained above. By analyzing the significance of employment, we find that this variable is not defined as migratory behavior, taking into account the respective country, but that spatial lag employment ( $W * \text{Unemployment}$ ) is. This suggests that when unemployment conditions are severe in neighboring countries, a country may become the recipient of unemployed labor of these near countries (with the sign of the lagged variable). This last statement holds regardless of the wages of neighbors, leading to the conclusion that the migration in a country does not react to changes in the relative wages of its neighbors (the spatial lag of wages is not significant).

## CONCLUSIONS

This paper estimates an econometric model that allows us to control for a spatial component in migration to the Americas. This spatial component is considered to be a determinant of migration dynamics of the continent, taking into account differences in living conditions and incomes of the countries analyzed. It explains the determinants of migration in the Americas during the period 1980 to 2005.

The results show that in all the estimated models, the space factor is significant and explains the migratory behavior in a moderate extent. The spatially lagged independent variables provide the motivations to migrate and explain how migration reacts in a country depending on what happens with neighboring nations.

Conditions such as unemployment affect a country more in terms of its net attraction of population if neighbors have problems linking the entire workforce. In this case, the estimates show that the greater the unemployment in surrounding countries the more migrants who are attracted to a country. However, as stated in classical macroeconomics, relative wages reflect migratory behavior. This is reflected in the wide scale showing this variable observed in the migratory flows each the country.

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## ANNEXES

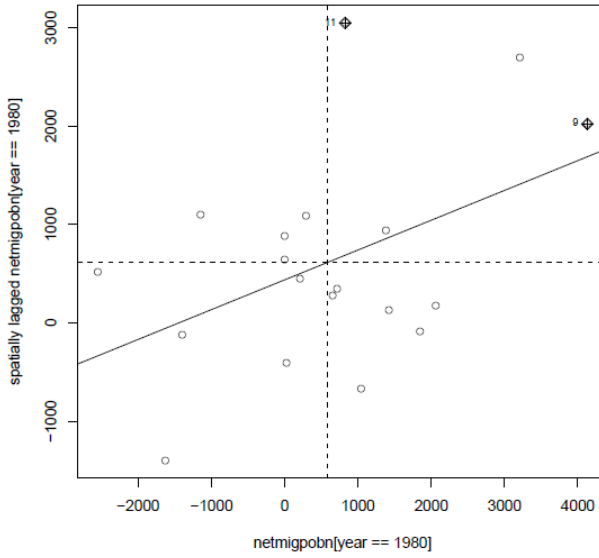


Figure 1. Moran scatterplot of net migration in 1980

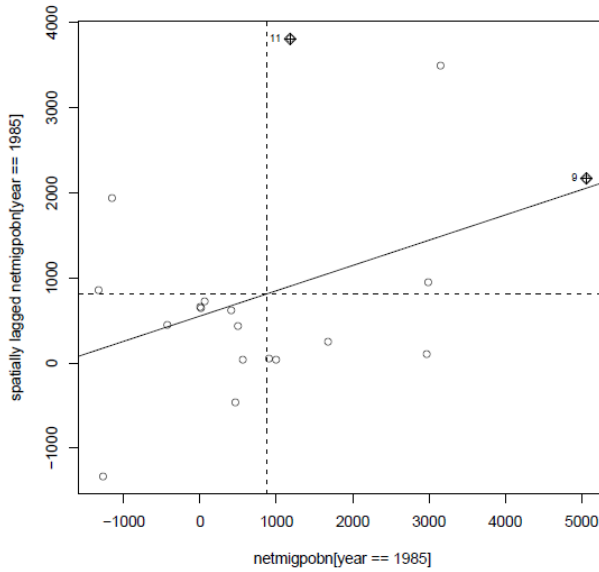


Figure 2. Moran scatterplot of net migration in 1985

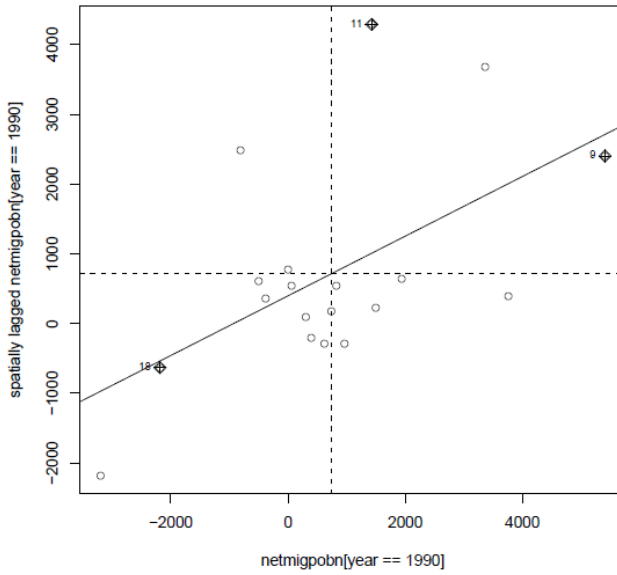


Figure 3. Moran scatterplot of net migration in 1990

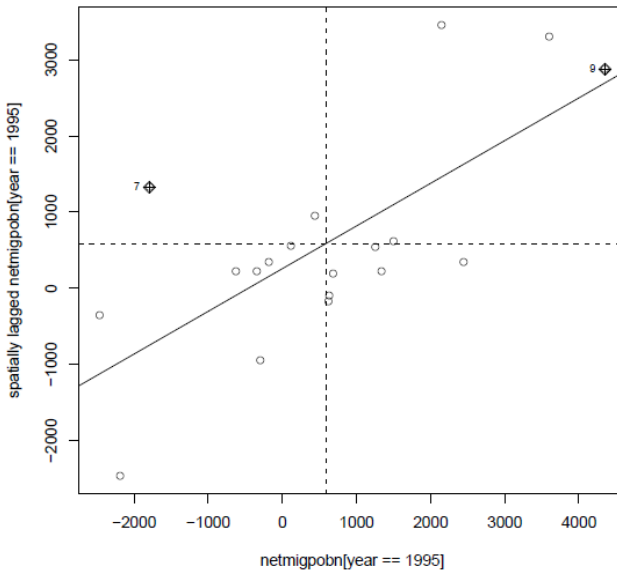


Figure 4. Moran scatterplot of net migration in 1995



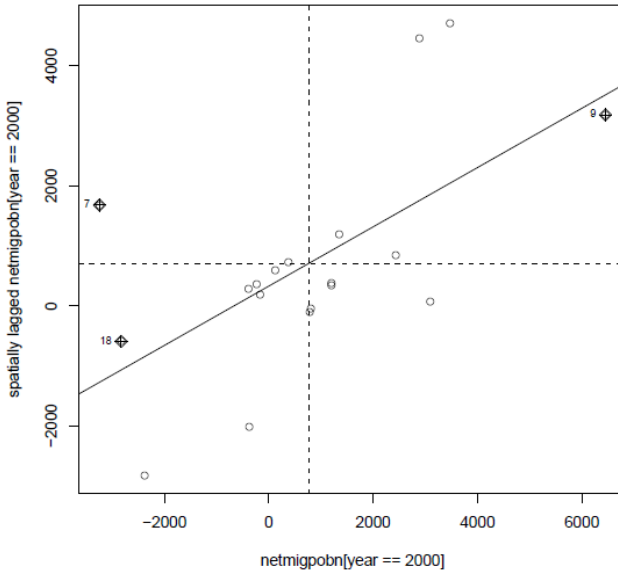


Figure 5. Moran scatterplot of net migration in 2000

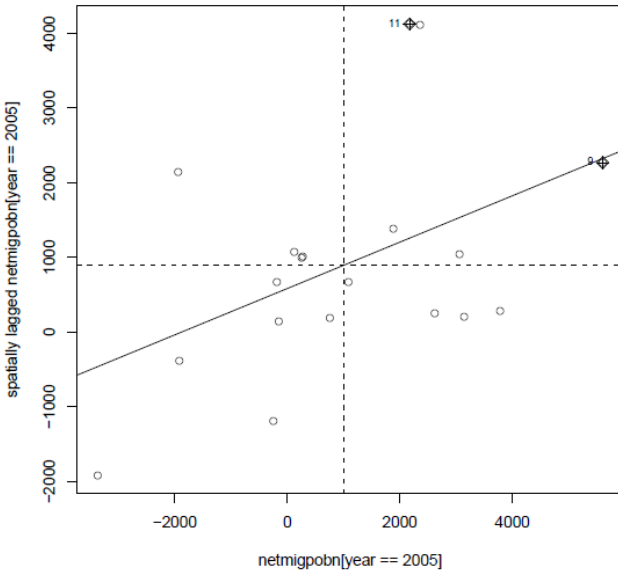


Figure 6. Moran scatterplot of net migration in 2005

Table 1. Moran statistics for net migration with different spatial weight matrices

		P Value	Moran I Statistics (*)	Variance
Spatial weights	1980	0.0964	0.1796	0.0326
	1985	0.125	0.1500	0.0319
	1990	0.0161	0.3241	0.0314
	1995	0.0119	0.3551	0.0331
	2000	0.0495	0.2381	0.0317
	2005	0.1071	0.1708	0.3321
Inverse distance weights	1980	0.2716	-0.0191	0.0036
	1985	0.1956	-0.0046	0.0035
	1990	0.0659	0.0332	0.0035
	1995	0.0538	0.0417	0.0036
	2000	0.2381	-0.0134	0.0035
	2005	0.2378	-0.0124	0.0037
Inverse of squared distance weights	1980	0.3112	0.0028	0.0140
	1985	0.3138	0.0014	0.0138
	1990	0.1105	0.0869	0.0135
	1995	0.0701	0.1206	0.0143
	2000	0.2316	0.0302	0.0136
	2005	0.2552	0.0232	0.0143

(\*) Expectation for all values: -0.0556

Null hypothesis: Non-spatial correlation.

Source: Prepared by authors based on World Bank data.

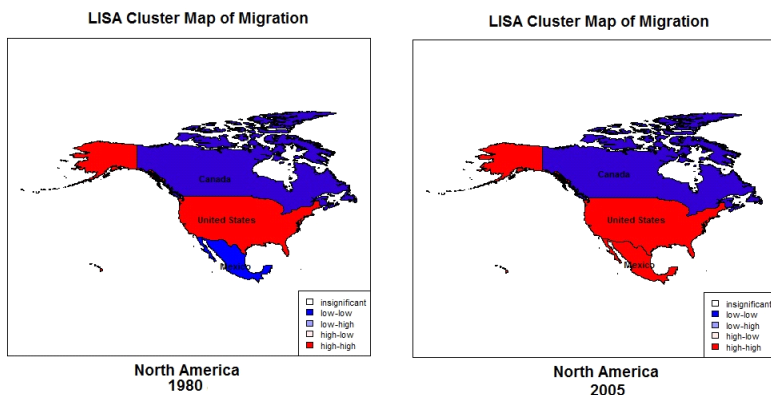


Figure 7. Spatial correlation of net migration in North America (LISA Analysis)

Source: Prepared by authors based on World Bank data.

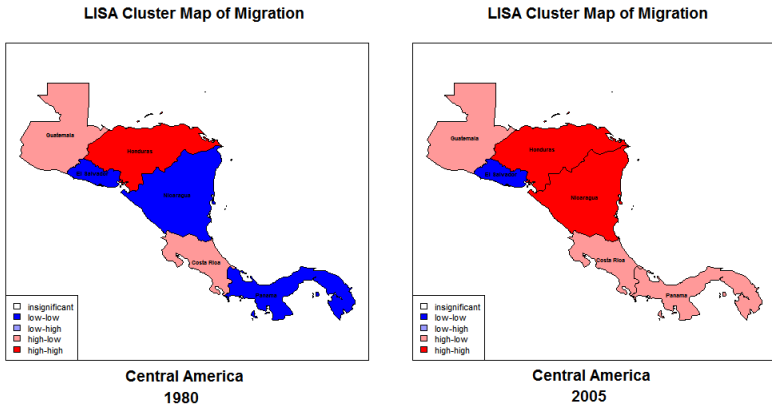


Figure 8. Spatial correlation of net migration in Central America (LISA Analysis)

Source: Prepared by authors based on World Bank data.

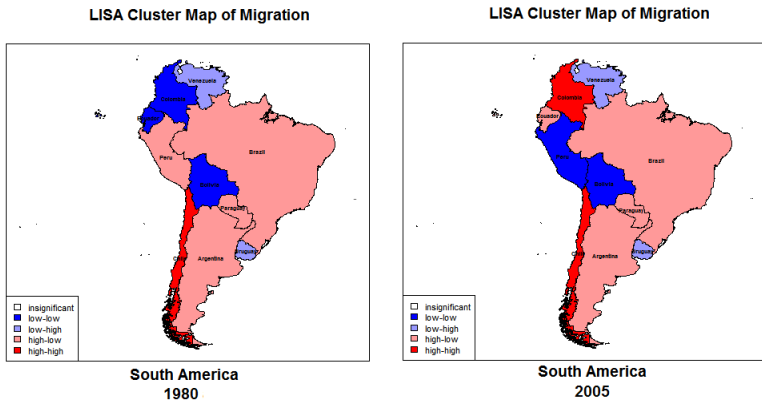


Figure 9. Spatial Correlation of net migration especially in South America (LISA Analysis)

Source: Prepared by authors based on World Bank data.

Table 2. Variables List

Variable	Characterization	Source
Net migration	The number of immigrants minus the number of emigrants, including citizens and non-citizens, for a period of five years.	World Bank
Relative wages	Real wage index to 2005 in the U.S.	Elaborated from the wage index of the ILO
Unemployment rate	Proportion of the labor force that is without work but available and looking for work. Information is total and by gender.	World Bank
Population from 14 to 65 ages	Percentage of the total population between 15 and 64 years.	World Bank